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GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
SPONSORED PROJECT INITIATION

Date: February 9, 1977

Project Title: The Edge-Function Method for 3-Dimensional Elasticity

Project No: E-20-612 (Co-project to E-23-627)

Project Director: Dr. J. E. Fitzgerald

Sponsor: National Science Foundation

Agreement Period: From 2/1/77 Until 7/31/78
(12 months budget period plus 6 months flexibility period)

Type Agreement: Grant No. ENG76-16418

Amount:		CE		ES&M		TOTAL
	NSF	E-20-612	$21,262	E-23-627	$28,638	$49,900
	GIT	E-20-344	1,107	E-23-327	3,321	4,428
	TOTAL		$22,369		$31,959	$54,328

Reports Required: Annual Letter Technical; Final Report

Sponsor Contact Person (s):

Technical Matters

Contractual Matters
(thru OCA)

Mr. James L. Bostick
Grants Officer
National Science Foundation
Washington, D. C. 20550

Defense Priority Rating: None

Assigned to: Civil Engineering (School/Laboratory)

COPIES TO:

- Project Director
- Division Chief (EES)
- School/Laboratory Director
- Dean/Director–EES
- Accounting Office
- Procurement Office
- Security Coordinator (OCA)
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- Library, Technical Reports Section
- Office of Computing Services
- Director, Physical Plant
- EES Information Office
- Project File (OCA)
- Project Code (GTRI)
- Other

GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION SHEET

Date 2/8/82

Project Title: The Edge-Function Method for 3-Dimensional Elasticity

Project No: E-20-612

Project Director: Dr. S. Atluri/Dr. J. E. Fitzgerald

Sponsor: National Science Foundation

Effective Termination Date: 12/31/79

Clearance of Accounting Charges: 12/31/79

Grant/Contract Closeout Actions Remaining:

- [ ] Final Invoice and Closing Documents
- [x] Final Fiscal Report
- [x] Final Report of Inventions
- [ ] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other _____

Co-project No. E-23-627 transferred to this project.

Assigned to: CE (School/~~Laboratory~~)

COPIES TO:

Administrative Coordinator
Research Property Management
Accounting
Procurement/EES Supply Services
Research Security Services
~~Reports Coordinator (OCA)~~
Legal Services (OCA)
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Computer Input
Project File
Other _____

FORM OCA 10:781

E 20-612

GEORGIA INSTITUTE OF TECHNOLOGY

J. E. FITZGERALD
DIRECTOR
SCHOOL OF CIVIL ENGINEERING
ATLANTA, GEORGIA 30332

(404) 894-2201

March 20, 1978

E-20-612/E-23-627
Annual Report No. 1
Submitted to NSF w/Continuation
Request dated 3/24/78

MEMORANDUM

TO: Dr. C. J. Astill

FROM: J. E. Fitzgerald and S. Atluri

SUBJECT: Renewal Request for Grant NSF 7616418

We should like to request a renewal of grant NSF 7616418 for a period of 12 months commencing on 1 July 1978 at the previously agreed funding level (budget attached).

The accomplishments to date are briefly summarized below (refer to original proposal for details of tasks).

Task I

We have derived the wedge and plane functions and the spherical polar solutions. We have produced the Boussinesque particular solution functions for distributed loads on 3-D solids. We have produced the global asymptotic solution functions near planar crack fronts in 3-D problems.

We have not completed the cylinderical polar solution functions. The super element was not pursued but has been deferred in favor of greater emphasis on the crack problem.

Task II

We have established the boundary surface identity for rectangular and triangular regions.

Task III

We have made progress toward increasing computational efficiency by introducing banding matrix solution methods. This effort has not been completed.

Task IV

We have not extended the above method to anisotropic 3-D media and have not pursued this effort but plan to pursue it in the second year. Again, the emphasis was shifted to the fracture problem.

XC: Mr AH Becker (2 cys) — For Record Purposes
Files E-20-612/E-23-627

Task V

We have done 3-D traction boundary condition problems for rectangular boundary elements. Mixed boundary condition problems will be done in the second year. We made substantial progress in solving embedded crack problems. Solutions are expected in July.

The coming year's effort will emphasize the following items:

- surface crack problems
- increased efficiency of solution methods for traction boundary problems with cracks which intersect a free surface
- complete the development of the cylinderical polar solutions and use them to solve thick plates with through holes
- investigate problems where one of the dimensions is of epsilon order with respect to the other two, i.e. determine dimensional limits of methods
- use Tchebychev polynominals in boundary identity
- test problems will be finalized

The use of a post-doctoral fellow has greatly improved the rate of progress in the various tasks. We intend to continue in that mode of operation.

Presentations were made, or will be made, as listed below. Copies of the presentations and/or papers are appended.

- Quinlan, P.M.; J. E. Fitzgerald; S. N. Atluri, "The Edge-Function Method" presented at the International Symposium on Innovative Numerical Analysis in Applied Engineering Science, Versailles, France, 23-27 May, 1977.
- Quinlan, Grannell, Atluri, and Fitzgerald, "Boundary Discretization Using the Edge-Function Method: Three Dimensional Elasticity" for presentation at the International Seminar on Recent Advances in Boundary Element Methods, University of Southampton, U.K., 5-7 July, 1978. (Also to be published).
- Quinlan, P.M.; Grannell, J; Atluri, S.; Fitzgerald, J.E.; "3-Dimensional Elasticity Solutions Using Edge Function Method," for presentation at The 8th U.S. National Congress of Applied Mechanics, University of California at Los Angeles, June 26-28, 1978.

JEF:bjm

J. E. Fitzgerald

S. Atluri

E-20-612

NATIONAL SCIENCE FOUNDATION
Washington, D.C. 20550

FINAL PROJECT REPORT
NSF FORM 98A

PLEASE READ INSTRUCTIONS ON REVERSE BEFORE COMPLETING

PART I–PROJECT IDENTIFICATION INFORMATION

1. Institution and Address	2. NSF Program	3. NSF Award Number
GIT Civil Engineering Atlanta, GA 30332	Solid Mechanics	ENG-76-16418
	4. Award Period From 2/1/77 To 12/31/79	5. Cumulative Award Amount 99,900

6. Project Title

Edge Function Method for 3-Dimensional Elasticity

PART II–SUMMARY OF COMPLETED PROJECT *(FOR PUBLIC USE)*

Summary of Completed Project

In this project, a novel and efficient method of analysis of stress and strain in a three-dimensional solid body subject to arbitrary mechanical loading, has been developed. This method, generally referred to as the Edge-Function Method, is generally limited to linear problems (i.e., the load-response characteristic is linear), but has been established to be superior to other presently available analysis methods.

A significant achievement of the project has been the development of a general solution for the problem of an elliptical crack (or surface of discontinuity) embedded in a three-dimensional solid body. This general solution was used as a basis for developing novel and accurate procedures for analysing surface flaws and cracks in everyday structural components. These analyses provide the basis for fracture susceptibility and integrity evaluation of these structural components. Applications of the basic research performed in this project are manyfold: structural integrity and fracture control studies of (i) aerospace structural components such as aircraft attachment lugs, (ii) pressure vessels and piping used in nuclear reactor systems, and (iii) ship hull structures. Examples of some of these applications have also been published in research papers written during the course of this project.

PART III–TECHNICAL INFORMATION *(FOR PROGRAM MANAGEMENT USES)*

1. ITEM *(Check appropriate blocks)*	NONE	ATTACHED	PREVIOUSLY FURNISHED	TO BE FURNISHED SEPARATELY TO PROGRAM	
				Check (✓)	Approx. Date
a. Abstracts of Theses			✓		
b. Publication Citations			✓		
c. Data on Scientific Collaborators			✓		
d. Information on Inventions	X				
e. Technical Description of Project and Results			✓		
f. Other *(specify)*					

2. Principal Investigator/Project Director Name *(Typed)*	3. Principal Investigator/Project Director Signature	4. Date
S. N. Atluri and J. E. Fitzgerald		12/15/81

NSF Form 98A (5-78) Supersedes All Previous Editions

Form Approved OMB No. 99R0

INSTRUCTIONS FOR FINAL PROJECT REPORT
(NSF FORM 98A)

This report is due within 90 days after the expiration of the award. It should be submitted in two copies to:

National Science Foundation
Division of Grants and Contracts
Post-Award Projects Branch
1800 G Street, N.W.
Washington, D.C. 20550

INSTRUCTIONS FOR PART I

These identifying data items should be the same as on the award documents.

INSTRUCTIONS FOR PART II

The summary (about 200 words) must be self-contained and intelligible to a scientifically literate reader. Without restating the project title, it should begin with a topic sentence stating the project's major thesis. The summary should include, if pertinent to the project being described, the following items:

- The primary objectives and scope of the project.
- The techniques or approaches used only to the degree necessary for comprehension.
- The findings and implications stated as concisely and informatively as possible.

This summary will be published in an annual NSF report. Authors should also be aware that the summary may be used to answer inquiries by nonscientists as to the nature and significance of the research. Scientific jargon and abbreviations should be avoided.

INSTRUCTIONS FOR PART III

Items in Part III may, but need not, be submitted with this Final Project Report. Place a check mark in the appropriate block next to each item to indicate the status of your submission.

a. Self-explanatory.
b. For publications (published and planned) include title, journal or other reference, date, and authors. Provide two copies of any reprints as they become available.
c. Scientific Collaborators: provide a list of co-investigators, research assistants and others associated with the project. Include title or status, e.g. associate professor, graduate student, etc.
d. Briefly describe any inventions which resulted from the project and the status of pending patent applications, if any.
e. Provide a technical summary of the activities and results. The information supplied in proposals for further support, updated as necessary, may be used to fulfill this requirement.
f. Include any additional material, either specifically required in the award instrument (e.g. special technical reports or products such as films, books, studies) or which you consider would be useful to the Foundation.